



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(54) Title:</b> METHOD OF UTILIZING PACKAGES BY MEANS OF A STRETCHABLE ADHESIVE TAPE		
<b>(57) Abstract</b>  <p>This invention relates to means for securing objects together for storage, shipping, or other purposes. In many manufacturing plants, packages are at some point grouped with other or packages to facilitate handling, storage, and shipping. Such grouping is commonly referred to as "unitizing". Perhaps the most common form of unitizing is palletization. The major share of pallet stabilization is being accomplished with stretch wrap. It would be desirable to find a wrapping or strapping material that would avoid the following problems: (4) elimination of excessive amounts of waste material, e.g., used stretch wrap; (5) minimizing excessive looseness of strapping material, which results in movement of packages; and (6) minimizing excessive tightness of strapping material, which results in damaging packages. This invention provides means for unitizing objects, e.g., packages, through the use of a stretchable, tackifiable, pressure-sensitive adhesive tape. The tape comprises a highly extensible, substantially non-recoverable backing bearing on at least one major surface thereon a layer of pressure-sensitive adhesive.</p>		

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METHOD OF UNITIZING PACKAGES BY MEANS  
OF A STRETCHABLE ADHESIVE TAPE

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1. Field of the Invention

This invention relates to means for securing objects together for storage, shipping, or other purposes.

2. Discussion of the Art

In many manufacturing plants, products or packages are at some point grouped with other products or packages to facilitate handling, storage, and shipping. Such grouping is commonly referred to as "unitizing". Perhaps the most common form of unitizing is palletization. As a specific facet of unitization, palletization becomes a process in which the unit load is joined with a pallet to provide for handling, primarily, with fork lift trucks. A palletized load must have vertical strength and horizontal or lateral stability. The stacking strength of a load (particularly loads of products packaged in cartons or containers) depends on the pattern or layout of each tier. For most cases, a column stack (one box directly on top of another) yields the greatest vertical strength. The column stack, however, has little lateral stability. Interlocking patterns increase lateral stability at some sacrifice in vertical strength. These patterns additionally can be used to optimize pallet space utilization. The end result of balancing vertical stacking strength, lateral stability, and space utilization can be an array of pallet patterns, requiring a different one for each product or package being palletized.

Several equipment manufacturers have added a horizontal strapping section to their palletizers to

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stabilize loads during the palletizing operation. Besides saving space, cutting labor costs, and simplifying handling, strapping during palletizing is also effective for stabilizing extremely unstable loads before they must be handled. Usually two or three strapping tiers will stabilize most loads, with many users strapping only the second layer from the top.

One means of providing lateral stability at low cost has been the use of adhesives to bond the layers of the load together. Adhesives for this purpose must have good shear strength to resist lateral forces that would cause a load to come apart. They must also have low tensile strength so that the load can be disassembled without damaging the product or package. Steel and, more recently, plastic strappings have been used for securing unitized and palletized loads. The plastics, e.g. polypropylene, nylon, and polyester, have replaced steel in enough applications so that now 80% of the strapping used for general palletizing is plastic. Of the plastics, polyester has been the most frequently used replacement for steel strapping, on account of the high breaking strength of the newer polyester products.

A few years ago, shrink wrapping of pallet loads generated considerable enthusiasm. While insuring load integrity, shrink wrapping also provided protection from dust, dirt, water, and pilferage. In more recent years, however, shrink wrapping has lost some of its initial appeal because of rising energy costs. The large ovens used to shrink the films around pallets consume too much energy and the resultant costs have caused shrink wrap to lose ground to the more energy-efficient stretch wrap.

The major barrier to shrink wrap stabilization is the energy required to shrink the wrap. The variety of shrink wrapping runs from hand-applied manual wrapping to automatic

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high-speed systems.

One area of unitization that is becoming more and more popular is bundling. Lumber, sheets of insulation, and bags of pet food have enjoyed successful bundling applications. Bundling has found application in a number of different industries, including the manufacture of lighting fixtures. Palletizing, unitizing, securing, wrapping, and bundling with strapping, adhesives, shrink wraps, or stretch wraps are activities common to nearly every packaging and shipping department.

It would be desirable to find a wrapping or strapping material that would avoid the following problems:

15

- (1) pull of fibers from the surface of containers on account of aggressive, sticky adhesives;
- (2) elimination of heating equipment needed to shrink wrapping material;
- (3) elimination of additional mechanical devices to secure palletized loads, e.g., clips to join the ends of strapping material;
- (4) elimination of excessive amounts of waste material, e.g., used stretch wrap;
- (5) minimizing excessive looseness of strapping material, which results in movement of packages;
- (6) minimizing excessive tightness of strapping material, which results in damaging packages; and
- (7) prevention of circulation about the unitized load in order to minimize moisture accumulation.

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Summary of the Invention

This invention provides a means for unitizing objects, e.g., packages, through the use of a stretchable, detachifiable, pressure-sensitive adhesive tape. In the preferred embodiment, the tape comprises a highly extensible, substantially non-recoverable backing bearing on at least a major surface thereof a layer of pressure-sensitive adhesive. This tape has the dual capability of (1) being capable of being firmly bonded to a substrate (2) being detachified after being stretched.

In order to unitize a group of objects, a small portion of the tape, usually from a roll, is first applied to a first object. The tape, if in a roll, is then simultaneously wound, stretched to induce detachification, and applied around the remaining objects; finally, the tape is stretched, detached, and the group is removed merely by releasing the tape from the regions where the tape portions are adhered.

The backing of the pressure-sensitive adhesive tape preferably has a Young's modulus of at least 2,500 psi (176 kg/cm<sup>2</sup>), more preferably at least 3,000 psi (211 kg/cm<sup>2</sup>), but less than 30,000 psi (2110 kg/cm<sup>2</sup>), most preferably between 5,000 psi (352 kg/cm<sup>2</sup>) and about 30,000 psi (2110 kg/cm<sup>2</sup>). The backing is elongated a lengthwise elongation at break of at least 150%, more preferably at least 200%, and most preferably at least 300%. The backing has low elastic recovery, e.g., less than about 30% elongation recovery after being stretched up to its breaking point, if the tape is to be used for unitizing a group of objects, a small portion of the tape, usually from a roll, is first applied to a first object. The tape, if in a roll, is then simultaneously wound, stretched to induce detachification, and applied around the remaining objects; finally, the tape is stretched, detached, and the group is removed merely by releasing the tape from the regions where the tape portions are adhered.

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it will retain sufficient residual resiliency to apply tension to the load of unitized objects, i.e., in the manner of a large rubber band. Unlike a rubber band, however, the tape preferably exhibits a low degree of recovery. Tape having a relatively higher degree of recovery can be used if it is applied by power-driven machinery and if it does not tackify upon recovery.

The layer of pressure-sensitive adhesive of the tape has sufficient shear strength and adhesive holding power to adhere to small regions of the objects to which the tape is attached. The holding power of the adhesive to a substrate is preferably greater than the cohesive strength of the adhesive and less than the adhesion of the adhesive to the backing, so that the adhesive layer of the tape, when the backing is subjected to stress, will not separate from the backing. The adhesive layer is also preferably highly cohesive, so that a portion of the tape can be removed from a surface to which it is attached at an angle of less than 35° without detaching it from the surface to which it is adhered.

The characteristic of the tape by means of which it adheres to the surface of an object as permanent adhesion is important, as permanent adhesion of the object upon removal of the tape that must remain sufficient area to constitute a relatively small quantity of tape to be applied. The characteristic of the tape by means of which it adheres to the surface of an object as permanent adhesion is important, as permanent adhesion of the object upon removal of the tape that must remain sufficient area to constitute a relatively small quantity of tape to be applied. The characteristic of the tape by means of which it adheres to the surface of an object as permanent adhesion is important, as permanent adhesion of the object upon removal of the tape that must remain sufficient area to constitute a relatively small quantity of tape to be applied.

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packages and for securing bundles of loose articles, such as for example, rods and objects made of wood, metal, or fibrous materials. In effect, the tape can be used as a replacement for string, twine, or wire.

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### Brief Description

FIG. 1 is a perspective view of packages arranged in tiers of stretchable, detachable adhesive tape wrapped around

FIG. 2 is a perspective view of packages arranged in the form of a stack of stretchable detackifiable adhesive tape wrapped around

15 FIG. 2a is a perspective view of a plurality of packages a single strip of stretchable pressure-sensitive adhesives of packages in a main package is minimized.

FIG. 3b is a perspective view of a plurality of packages shown in the arrangement rotated 90°.

FIG. 4a, 4b, and 4c illustrating how the detection method of this invention.

FIG. 5 is a plan view of the tape station and secured by a tape station of this invention.

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Detail

A tape suitable  
described in the assignee's  
35 Serial No. 1,001,173, is  
However, together with the  
suitable for the method  
tape 1 comprises a base

### the Drawings

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-sensitive  
of packages.

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Application  
20, 1990.  
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major surface thereof a layer of adhesive. The major surface of the layer of pressure-sensitive adhesive can optionally bear a layer of low-adhesive composition.

Materials suitable for the backing of the highly extensible tape useful in this invention include polymeric sheet materials having high tensile strength. (2) a lengthwise tensile strength of from about 50 to about 1,500 psi (3.4 to about 103.4 kg/cm<sup>2</sup>), more preferably from about 800% to about 1,500% still more preferably from about 800%; substantial elongation having less than about 100% stretched, more preferably recovery, still more elastic recovery; and about 3,500 psi (241.3 kg/cm<sup>2</sup>) to about 3,000 psi (210.8 kg/cm<sup>2</sup>), more preferably about 7031 kg/cm<sup>2</sup> psi, more preferably about 20 psi (3.4 kg/cm<sup>2</sup>) and suitable method for measuring material is described in Standard Test Methods for Plastic Sheetings. If the tape loses its pliability when stretched, rubbery materials suitable for the backing of the tape include polyolefins, such as density polyethylene, low density polyethylene, polyethylene copolymers, such as polyethylene/propylene copolymers, plasticized polyolefins, olefin copolymers, copolymers of ethylene/acrylonitrile, and ethylene/propylene copolymers and materials suitable for the backing of the tape include polyethylene, linear polyethylene, low density polyethylenes; vinyl acetates; acrylicates; copolymers, and copolymers and

copolymers and combinations of the foregoing. Mixtures or blends of any plastic or plastic and elastomeric materials such as polypropylene/polyethylene, polyurethane/polyolefin, polyurethane/polycarbonate, polyurethane/polyester, can also be used. Backings are typically in the form of single or multi-layer films. Backings are preferably selected from polyethylene and polypropylene films, with the most preferred materials being linear low density and ultra low density polyethylene films. Backings can be made by any known method of film forming, such as, for example, extrusion, co-extrusion, solvent casting, foaming, non-woven technology, etc. The backing can have any thickness as long as it possesses sufficient integrity to be processable and preferably ranging from 10 micrometers to 750 micrometers. Backings about 10 micrometers thick are preferred for aggressive adhesives. Backings about 750 micrometers thick are preferred for stretching forces that are higher than 10 N/dm<sup>2</sup>, thereby making application more difficult, except for power driven machines.

The adhesive layer can comprise any pressure-sensitive adhesive, with particular adhesion being preferred. The use of pressure-sensitive adhesives, with generally a modulus ranging from 4 N/dm<sup>2</sup> to about 100 N/dm<sup>2</sup>, is preferred. The peel angle is preferably above 180°, according to PSTC-1 and PSTC-3 or ASTM Designation D903-97, at a peel rate of 12.7 cm/min.

The adhesive layer can be suitable for this in particular, such as natural rubber, polybutadiene, polyisoprene, and styrene-butadiene block copolymers, such as polyisoprene, polyisoprene-styrene copolymers, and

other elastomers; and tackified or untackified acrylic adhesives, such as copolymers of isooctylacrylate and acrylic acid, which can be polymerized by radiation, solution, suspension, or emulsion techniques. The most preferred adhesives are tackified block copolymers. For some purposes, adhesives that are incapable of providing enhanced adhesion over time are desired, so that removal of the tape by peeling at a less than optimum angle will not grossly deface the package.

The thickness of the adhesive layer can range from about 15 micrometers to 1,000 micrometers, preferably from about 10 micrometers to about 400 micrometers. In this range of thicknesses, the thinner layers will peel more easily than will thicker layers. Also, the dry coating weight of the adhesive in the adhesive layer can range from about 1/2 gram/24 sq. in. to about 50 grams/24 sq. in. (0.021 grams/sq. in. to 2.083 grams/sq. in.).

As the tape is peeled, the adhesive must detackify. As used herein, the term "detackification" means reduction of the adhesive strength as measured by the Peel Force-Sensitive Test. The test will be described in detail in a separate technical matter, upon which the present invention is based. In any event, upon stretching, tack is reduced by at least 10%, and more preferably by at least 20%. It is more preferred that the adhesive be tackified so that the dry weight of the adhesive layer decreases as the increased area of the surface is exposed. Surprisingly, the level of detackification would have been expected to be proportional to the dry weight per unit area of the adhesive.

The tape can be produced by any conventional means, including pressure sensitive adhesive, for example, the adhesive can be applied to the

backing, which can be  
 then later eliminated in  
 order to improve adhesion  
 backing, or backing of  
 5 coating on the backing  
 the following ways: (1)  
 flame treatment, electro-  
 radiation, cold etch  
 pretreatment can be  
 10 reactive, alcohol ad-  
 hydroxy, acrylate  
 other reaction, special  
 discharge pretreatment  
 polymerized on back-  
 15 it is a  
 roll, it is preferred  
 backing, bearing  
 a layer of low-ad-  
 to allow it in un-  
 20 of pressure, insiti-  
 release, etc. Low  
 suitable to the to  
 selected, for exam-  
 example, for exam-  
 25 4,279,771, 4,281,771,  
 in FIG. 1, tape  
 objects, e.g., pad  
 more than one object  
 30 embodiment, could be  
 light, e.g., e-  
 at a low cost of  
 in FIG. 1, tape  
 35 objects, e.g., pa-  
 more than one object  
 second, e.g., e-  
 wrapper, e.g., e-

the layer and  
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 prior to the  
 one or more of  
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 as, for  
 U.S. 2,532,011;  
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 short distance

it, as shown  
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 ing on one or  
 and the  
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 tional

strips of tape 28, 30. . .  
 addition of . . .  
 42.

to wrap  
as 36, 38, 40,

5 FIG. 3a FIG. 3b, a  
crossing pattern are  
packages arranged  
pattern provides equal  
stabilizing the object  
10 shifting the exposed  
pattern could be exposed  
handling, e.g., over  
at a high rate of speed

is shown in  
 applied in a  
 e.g.,  
 ers. This  
 forces that  
 them from  
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 for severe  
 g distances

15 shown in 3a a  
attach a tion of  
point A. e porti  
around a mer of  
stretching of the  
20 release the se  
then str and  
sequence second  
package at point  
the first package  
25 point E. sixth  
package at point  
the fifth package  
point J. four  
package . point  
30 L, the pack  
52 at p the  
second p e 52  
point J. fifth  
package poi.  
35 L, the pack  
52 at p and  
- 50  
packages . 51

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e 52 at  
wrapped  
ubsequent  
e tape to  
Tape 50 is  
in  
third  
at point D,  
ckage 52 at  
eventh  
at point H,  
ckage 52 at  
tenth  
52 at point  
th package  
t K, the  
age 52 at  
e eighth  
52 at point  
elfth package  
point A.  
o the  
e thereby

retaining some of its effect, the tape acts as a band. However, the recovery of a rubber is with-  
 5 include the pallet can be wrapped around the pallet bearing the detail.  
 10 tape allows the tape without damaging the also been found that the tensile strength  
 15 seen how the tape 60 pressure sensitive stretches without premature If less than 45° from  
 20 the portion of the object 66 will remain will not be pulled at an angle the horizontal,  
 25 tape 60 adhered to detaching and the adhered surface angle of greater in FIG. the  
 30 surface will tape 60 is removed. Alternatively, the sufficient care removing the the  
 35 the tape adhered to the group of objects of short length

properties. In are a large rubber exhibits much less

this invention to t, i.e., the tape s to be stored and

characteristic of the from the objects objects. It has tape also increases

and 4c, it can be 62 and a layer of e pulled and object 66 led at an angle of s shown in FIG. 4a, o surface 68 of the on of the tape 60 . If the tape 60 is ° to about 45° from the portion of the ot significantly e 60 will remain 60 is pulled at an horizontal, as shown 60 adhered to e portion of the ce 68.

e can exercise tape without ect the portion of

d to unitize a s than the amount red to unitize

those objects. An  
 disposal gener  
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 5 if they not d  
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 adhered to surfa  
 tape 72. When  
 shown) an simult  
 portion of the  
 15 point 1 of the  
 it is wrapped ar  
 After the box 70  
 78 of the tape 7  
 portion of attac  
 20 the tape 72 arou  
 adhesion between  
 only at points X  
 from the box 70.  
 box is wrapped  
 25 configurations  
 used to secure  
 other  
 herein include  
 a  
 30 automatic areas  
 necessary to co  
 to be wrapped  
 can be used to  
 Typical stre  
 35 rate, 10  
 is need  
 to  
 wind a

solid waste requiring  
 tion can be used to  
 r other objects even  
 d in a plurality of  
 platform.  
 tion can also be used  
 e.g., a box 70,  
 Referring to FIG.  
 as from a roll, is  
 at point X. The  
 the roll (not  
 to detachify the  
 to the box 70 at  
 tape 72 is unwound,  
 as to close it.  
 ted, a small portion  
 et stretched. This  
 to point Y to secure  
 0. Significant  
 a box 70 is obtained  
 pe 72 is removed  
 al damage to the  
 trapping  
 in FIG. 5 can be  
 boxes.  
 e tape described  
 insulating.  
 s, e.g., in the  
 , as it is  
 es of the surface  
 etching capability  
 conformity.  
 at a fairly low  
 es where conformity  
 apes can be used to  
 that is to be

connected to a second  
polytetrafluoroethy-  
lene can be used to gener-  
ally seal the three  
5 or low voltage  
stretched tape of  
purpose.

Another object of  
this invention is to  
10 by stretching and  
about the cables in  
adhesion  
stretching area of  
specifying the degree  
15 the appropriate area  
while not  
as the area previously  
bearing the stress of  
thereof is also a  
20 invention.

The following  
illustrate the method

25 Pressure Test  
One end of the tape  
adhered to an annular  
A stainless steel  
test piece (PE) (0.5  
30 diameter) is raised  
ring at a speed  
with the adhesive  
of one end, the  
adhesive is being  
35 to separate the  
is measured and  
test results are

method of employing a  
the stretchable tape  
in layer for the

for applications, the  
for insulation

on for the tape of  
a plurality of cables  
of this invention  
operation.

An object in the  
controlled by  
or by specifying

any useful functions  
tapes having backings  
major surfaces  
method of this

examples further  
invention.

One end of the tape is  
weight of 78.5 g.  
a polyethylene  
7/8 inch [0.95 cm] in  
diameter of the annular  
into contact  
after a dwell time  
d from the  
minimum force needed  
five-bearing surface  
details of this  
in D2979-82.



180° Peel Adhesion

- 1 sample  
(2.54 cm wide by 10  
long is adhered to a  
5 test panel having d  
(5.08 cm wide by f  
1/16 inch 0.159 cm  
test panel so that 1  
17.8 cm of the sam  
10 of the test panel.  
in each direction  
the same of the  
panel is doubled  
portion. It is p  
15 of the panel is cl  
tester. The end c  
to form tab. Th  
of the sample te  
rate of in/min  
20 value being noted.  
set forth in "T  
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Illinois with En

25 180° Peel Adhesion

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30 surface of one  
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180° Peel Adhesion

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35 180° Peel test  
a two inch s wi  
(0.41 inch thick  
material.

Steel

- dimensions one inch  
(25.4 to 30.5 cm)  
steel (AISI 302 or 304)  
of at least two inches  
long (12.7 cm) by  
the centerline of the  
even inches (12.7 to  
extend beyond the edge  
tape is rolled once  
roller. An end of  
t with the test  
approximately one inch  
test panel. The end  
jaw of the tensile  
tape is doubled over  
into the upper jaw  
separated at a  
average adhesion  
This of this test are  
ure-Sensitive  
cil, Glenview,

the same way as the  
the test surface is  
Mosinee Paper  
to the entire  
steel test panel

at

the same way as the  
the test surface is  
g by 0.165 inch  
Corrugated Box  
the lengthwise direction.

Mechanical Handling

- boxes in  
dimension 10 1/2  
(31.8cm) 15 1/2  
5 to 15 pallets (5.4m)  
stacked 11 ft thru  
on a standard 42 inch  
pallet. The proj  
with forces can en  
10 i.e., from back  
truck equipped wi  
and transport the  
course at a walki  
(152.4 ft/sec).  
15 to 11 ft. (3.4m)  
90° turn and an  
pallets are low ad  
in direction of the  
e.g., from and to  
20 test are run for

feet and having the  
12 1/2 inches  
and containing 12  
dunnage were  
box configuration  
11 inch (121.9 cm)  
truck equipped  
any direction,  
side. Using a lift  
engages, lifts,  
-shaped test  
d five ft/sec  
rise includes a 10  
e aisle with a  
ion zone. The  
n and are tested  
o each other,  
l details on this  
D1083-88.

Vibration Test

- unit  
Mechanical Handling  
25 onto a vibration  
Machine consists  
that distribute  
throughout the plate  
only vertically  
30 and amplitude of  
controllable, as  
break. The test  
frequency starts  
and then back to  
35 acceleration level  
details of this  
D3582-9.

ed in the  
test was loaded  
vibration Test  
test surface  
uniformly  
s driven to move  
The frequency  
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acceptable  
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eping to 100 Hz.  
eeps were run at  
Additional  
STM Designation

A series of tapes based pressure-sensitive adhesives were prepared to illustrate the effect of various fiber pull from the materials. Each tape consisted of coating one major surface of a low density polyethylene substrate with a tackified pressure-sensitive adhesive. The adhesive was a styrene-isoprene ("Kraton" 1107) tackified with a carbon resin ("Wingtack Extra").

The formulation of this example was similar to that in U.S. Patent No. 3,239,478, incorporated by reference, and is as follows:

	<u>Ingredient</u>	<u>Amount (phr)</u>
20	Styrene-isoprene block copolymer 1107, Shell	100
25	Hydrocarbon resin ("Wingtack Extra", Goodyear T	100
	Antioxidant Ciba-Geigy	1.5
30	Antioxidant American	1.5

The low adhesion backing was a copolymer of vinyl N-vinyl acetate, which was described in U.S. Patent No. 2,532,011.

The backing composition was applied to the major surfaces thereof. The composition was applied to the backing not bearing the adhesive of each of the tapes of the series,

including a block copolymer composition were applied to various surfaces, and various packaging tapes were prepared by coating a 0.013 cm linear backing with a tackified adhesive. The adhesive was a block copolymer of styrene-isoprene and carbon resin.

Adhesive of this type is described in U.S. Patent No. 3,239,478, incorporated by reference, and is as follows:

	<u>Ingredient</u>	<u>Amount (phr)</u>
	Styrene-isoprene block copolymer 1107, Shell	100
	Hydrocarbon resin ("Wingtack Extra", Goodyear T	100
	Antioxidant Ciba-Geigy	1.5
	Antioxidant American	1.5

The backing comprised a copolymer of vinyl N-vinyl acetate and vinyl acetate, which was described in U.S. Patent No. 2,532,011.

The backing was treated on both sides. The composition was applied to the backsize surface of the backing. The coating weight was 0.5 g/cm<sup>2</sup> and stretched to 0.1 g/cm<sup>2</sup> as set forth in Table 1.

1. The tape exhibited 7" by hand.

tion when stretched

5	Sample no.	Coating (unstretched)	Coating weight (stretched)
	1	0.014	0.014
	2	0.015	0.015
	3	0.020	0.020
	4	0.022	0.022
10	5	0.036	0.036
	6	0.043	0.043

The data in Table 1 indicates that the ultimate yield can give (approximately) in adhesion area. The reduction in the surface area results in a reduction in the ultimate yield. Adhesion, in this case, is set forth in Table

stretching to the reduction in weight per unit area result from an increase in the backing. This is due to tack and adhesion. The weight of the corrugated paperboard

Table 2

Sample no.	Adhesion (g/cm)		Fiber pull (%)	
	(unstretched)	(stretched)	(unstretched)	(stretched)
1	182.1	11.2	100	0
2	197.7	41.3	100	0
3	237.9	67.0	100	0
4	220.1	78.2	100	0
5	203.9	119.5	100	0

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Pressure-sensitive tack, in g/0.645 cm<sup>2</sup>, is set forth in Table 3.

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Table 3

<u>Sample no.</u>	<u>Tack - SS probe (g/0.645 cm<sup>2</sup>)</u>		<u>Tack - PE probe (g/0.645 cm<sup>2</sup>)</u>	
	<u>(unstretched)</u>	<u>(stretched)</u>	<u>(unstretched)</u>	<u>(stretched)</u>
1	1319	276	909	125
2	1381	494	977	301
3	1832	793	1273	254
4	2048	813	1424	370
5	2232	1210	1645	319
6	2156	969	1501	269

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In Table 4, both adhesion to the surface of fiberboard and fiber pull from the surface of fiberboard are set forth for the tape.



Table 4

<u>Sample no.</u>	<u>Adhesion (g/cm)</u>		<u>Fiber pull (%)</u>	
	<u>(unstretched)</u>	<u>(stretched)</u>	<u>(unstretched)</u>	<u>(stretched)</u>
1	156.4	111.7	97	35
2	156.4	156.4	93	73
3	167.6	167.6	93	97
4	167.6	145.2	97	36
5	212.2	167.6	95	60
6	167.6	178.7	95	87

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Example II

A series of tapes employing an acrylate-based pressure-sensitive adhesive composition was prepared to illustrate adhesion to various surfaces, and fiber pull from the surfaces of various packaging materials. Each tape of the series was prepared by coating one major surface of a 4 mil (0.0102 cm) LLDPE backing with a tackified pressure-sensitive adhesive. The adhesive was an acrylate adhesive comprising 90 parts by weight isooctyl acrylate and 10 parts by weight acrylic acid prepared according to Re. 24,906 (Ulrich), incorporated herein by reference. The backing had been corona treated on both major surfaces thereof. A low-adhesion backsize composition was applied to the major surface of the backing not bearing the adhesive. The low-adhesion backsize composition was of the type described in Example 1. The coating weight of adhesive of each of the unstretched and stretched tapes of the series, in g/m<sup>2</sup>, are set forth in Table 5.

20

Table 5

<u>Sample no.</u>	Coating weight	Coating weight
	<u>unstretched</u>	<u>stretched</u>
1	0.037	0.013
2	0.060	0.016
3	0.106	0.030
4	0.129	0.027

The data in Table 5 indicate that stretching to ultimate yield can give a 3.7 times reduction (approximately) in adhesive coating weight per unit area. The reduction is believed to result from an increase in the surface area of the backing.

Both adhesion to the surface of corrugated paperboard and fiber pull from the surface of corrugated paperboard are set forth in Table 6.

<u>Sample no.</u>	<u>Table 6</u> Adhesion (g/cm)		Fiber pull (%)	
	<u>(unstretched)</u>	<u>(stretched)</u>	<u>(unstretched)</u>	<u>(stretched)</u>
1	170.9	74.8	98	12
2	173.2	95.0	97	20
3	156.4	147.5	100	44
4	169.8	167.6	199	94

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Both adhesion to the surface of fiberboard and fiber pull from the surface of fiberboard are set forth in Table 7.

Table 7

<u>Sample no.</u>	<u>Adhesion (g/cm)</u>		<u>Fiber pull (%)</u>	
	<u>(unstretched)</u>	<u>(stretched)</u>	<u>(unstretched)</u>	<u>(stretched)</u>
1	164.2	103.9	75	5
2	158.6	153.0	100	100
3	150.8	167.6	100	100
4	164.2	175.4	100	77

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The data in the foregoing tables show that there is a greater decrease in adhesion than would have been expected from a mere reduction in adhesive coating weight. For example, the adhesion and tack of a tape having a stretched coating weight of 2.0 to 2.2 grains per 24 sq. in. [0.020 to 0.022 g/cm<sup>2</sup>] (i.e., Sample nos. 3 and 4) is significantly lower than the adhesion and tack of a tape having an unstretched coating weight of 2.1 grains per 24 sq. in. [0.021 g/cm<sup>2</sup>] (i.e., Sample no.1). A decrease in adhesion correlates directly with a reduction in tack, i.e., detackification.

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Example III

A group of containers was unitized by means of the stretchable tape disclosed herein in the manner shown in FIG. 3. The tape was applied by hand at a stretch ratio of 6 to 1. For the purpose of comparison, a second group of containers, identical to the first group, was unitized by means of stretch wrap, also applied by hand. Both groups of unitized containers were subjected to the mechanical handling test and the vibration (table) test. The load displacement for each type of wrapping was similar, and each type of wrapping was deemed to be adequate for use in a manufacturing facility.

The tape and stretch wrap were then removed from the unitized containers, and the scrap tape and scrap wrap were weighed. The stretch wrap weighed 7.4 ounces (1.02 kg). The stretch tape weighed 2.3 ounces (0.32 kg). Thus, the use of tape resulted in a 70% reduction in waste.

Various modifications and alterations of this invention will become apparent to those skilled in the art without departing from the scope and spirit of this invention, and it should be understood that this invention is not to be unduly limited to the illustrative embodiments set forth herein.

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## WHAT IS CLAIMED IS:

1. A method of unitizing at least two objects that are arranged in one or more tiers, at least one of said tiers comprising at least one object, said method comprising the steps of:

- (1) providing a stretchable, detackifiable pressure-sensitive adhesive tape having (1) a backing having a Young's modulus of at least about 2,500 psi (176 kg/cm<sup>2</sup>) but less than about 100,000 psi (7031 kg/cm<sup>2</sup>), a lengthwise elongation at break of at least about 150% and low recovery, (2) said backing bearing a layer of pressure-sensitive adhesive thereon;
- (2) adhering a first small portion of said tape to a small portion of one of said objects;
- (3) stretching said tape sufficiently to detackify the portion thereof not adhered to said one of said objects;
- (4) wrapping said detackified portions of said tape around at least two of said objects; and
- (5) adhering a second portion of said tape to a small portion of one of said objects, whereby said objects are capable of resisting mechanical handling and vibration of said arranged objects.

2. The method of Claim 1, wherein said objects are arranged in at least two tiers.



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3. The method of Claim 2, wherein said tape is wrapped around all of said objects on at least one of said tiers.

5 4. The method of Claim 1, wherein said objects comprise packages having at least six sides.

5. The method of Claim 1, wherein said tape is wrapped in a direction substantially parallel to the  
10 plane formed by the uppermost surfaces of said objects.

6. The method of Claim 1, wherein said tape is wrapped in a direction substantially non-parallel to the plane formed by the uppermost surfaces of said  
15 objects.

7. The method of Claim 1, wherein said tape is wrapped in both a direction substantially parallel to the plane formed by the uppermost surfaces of said  
20 objects and a direction substantially non-parallel to the plane formed by the uppermost surfaces of said objects.

8. The method of Claim 1, wherein at least  
25 one stretched and wrapped portion of said tape crosses over at least another stretched and wrapped portion of said tape.

9. A method of closing and securing a  
30 package comprising the steps of:

(1) providing a stretchable,  
detackifiable pressure-sensitive  
adhesive tape having (i) a backing  
having a Young's modulus of at  
35 least about 2,500 psi (176 kg/cm<sup>2</sup>)  
but less than about 100,000 psi  
(7031 kg/cm<sup>2</sup>), a lengthwise  
elongation at break of at least

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about 150% and low recovery, (2) said backing bearing a layer of pressure-sensitive adhesive thereon;

5

(2) adhering a first small portion of said tape to a small portion of said package;

10

(3) stretching said tape sufficiently to detackify the portion thereof not adhered to said package;

(4) wrapping said detackified portion at least partially around said package; and

15

(5) adhering a second small portion of said tape to a small portion of said package, whereby said package is capable of remaining closed and secured.

20

10. The method of Claim 8, wherein said package has at least six sides.

11. A method of unitizing a plurality of objects comprising the steps of:

25

(1) providing a stretchable, detackifiable pressure-sensitive adhesive tape having (1) a backing having a Young's modulus of at least about 2,500 psi (176 kg/cm<sup>2</sup>) but less than about 100,000 psi (7031 kg/cm<sup>2</sup>), a lengthwise elongation at break of at least about 150% and low recovery, (2) said backing having a layer of pressure-sensitive adhesive thereon;

30

35

(2) adhering a first small portion of

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said tape to a small portion of at least one of said objects;

(3) stretching said tape sufficiently to detackify the portion thereof not adhered to said object;

(4) wrapping said detackified portion of said tape around said plurality of said objects; and

(5) adhering a second portion of said tape to a small portion of at least one of said objects, whereby said plurality of said objects is unitized in the form of a bundle.

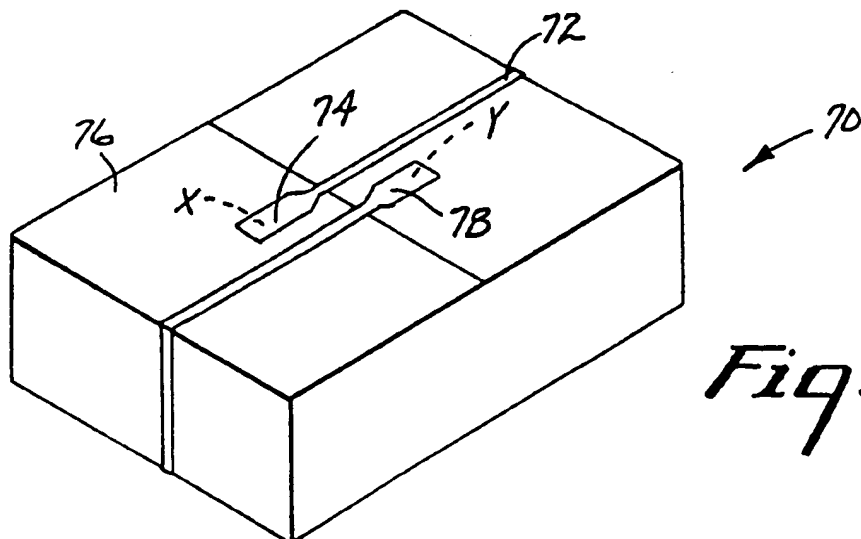
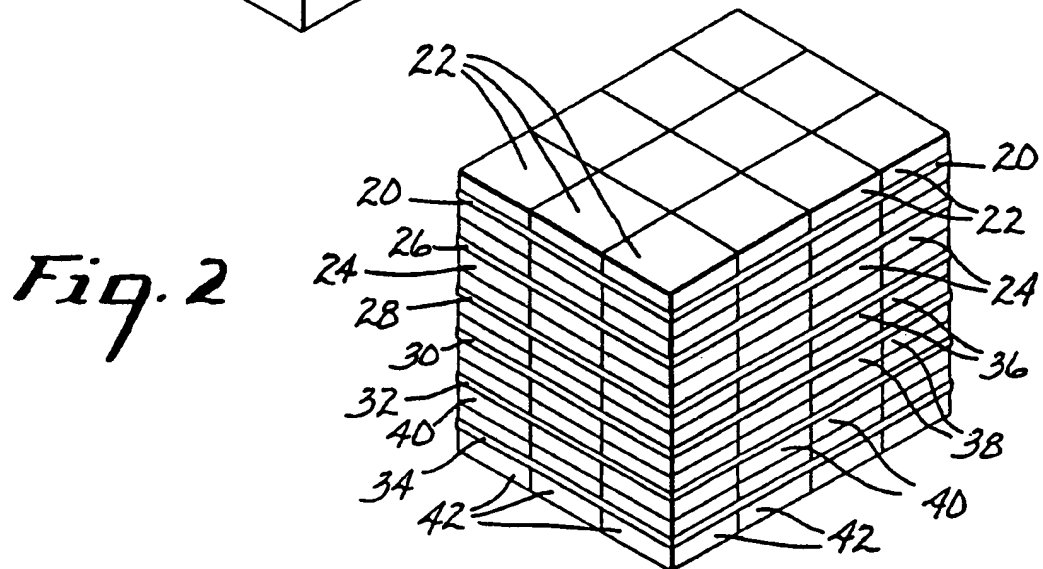
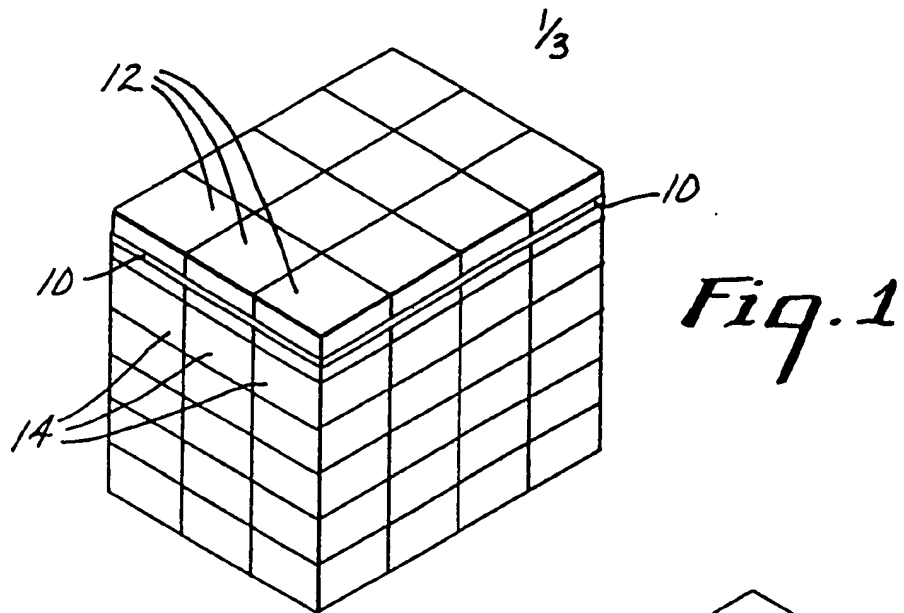
12. A stretchable, detackifiable

pressure-sensitive adhesive tape having a backing having a Young's modulus of at least about 2,500 psi (176 kg/cm<sup>2</sup>) but less than about 100,000 psi (7031 kg/cm<sup>2</sup>), a lengthwise elongation at break of at least about 150% and low recovery (a) said backing having a layer of pressure-sensitive adhesive thereon, said tape having a portion thereof stretched to at least 200% of its original length, whereby said tape detackifies by at least about 10%.

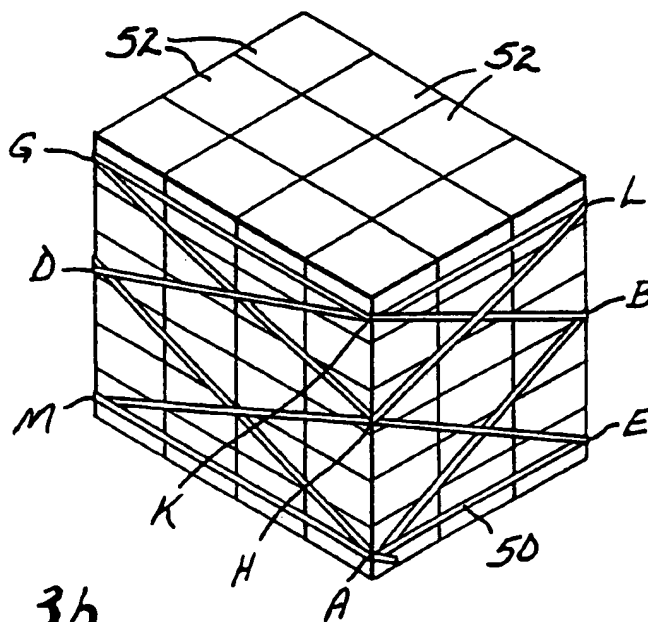
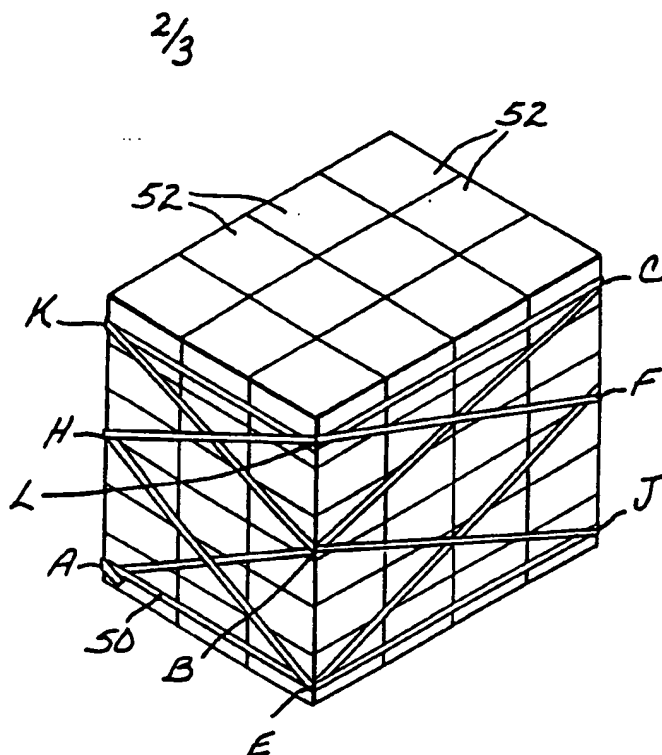
13. The tape of Claim 12, wherein said tape detackifies by at least about 25%.

14. The tape of Claim 12, wherein said tape detackifies by at least about 50%.

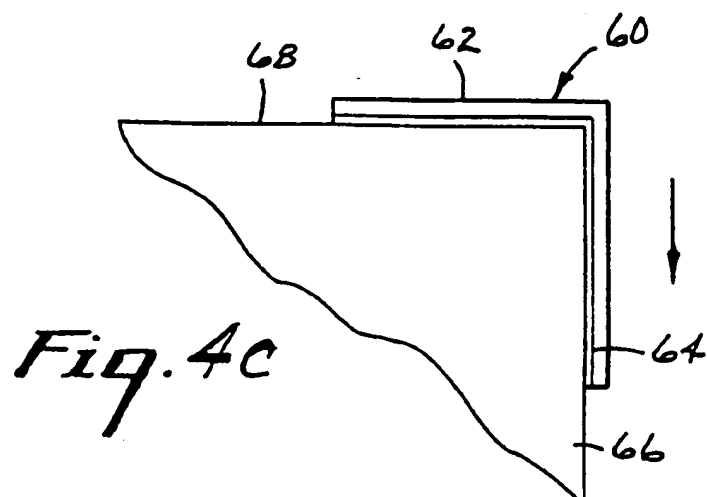
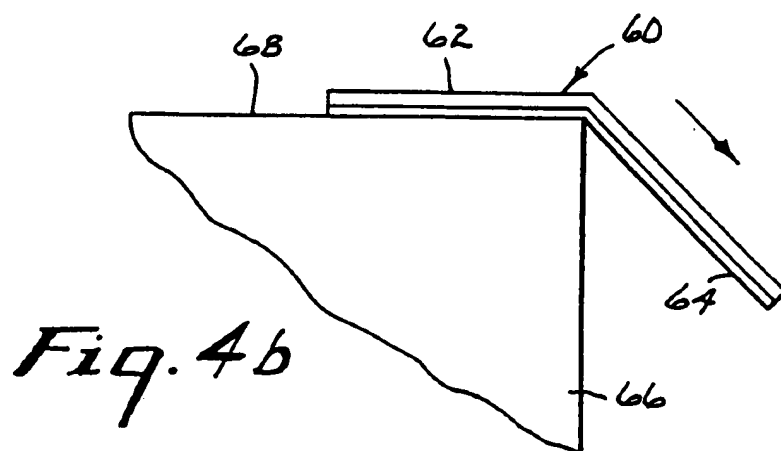
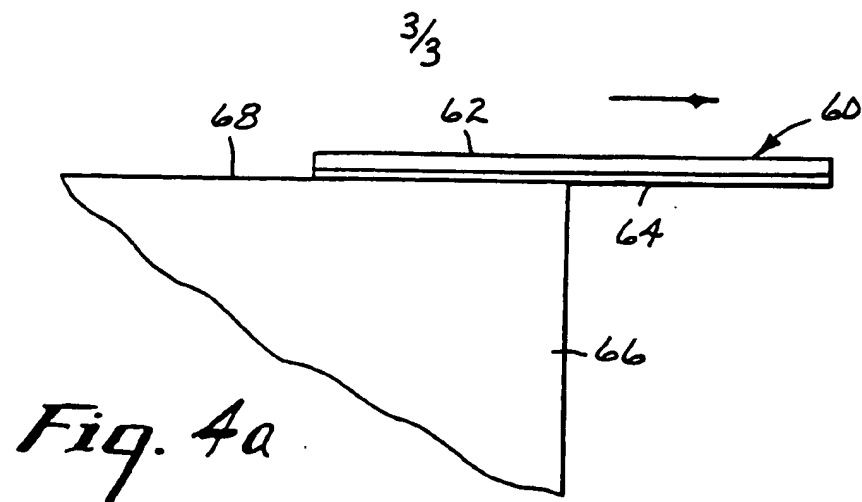
15. The tape of Claim 12, wherein said tape has a portion thereof stretched to at least 600% of its original length.



*Fig. 3a*




*Fig. 3b*



## INTERNATIONAL SEARCH REPORT

International Application No.

PCT/US 92/05128

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.Cl. 5 B65B13/02; B65B17/02; B65D71/00		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
Int.Cl. 5	B65B ; B65D	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>		
Category <sup>9</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
A	US,A,3 535 189 (J. HALL) 20 October 1970 see column 8, line 66 - column 10, line 39; figures	1,4,9-12
A	US,A,3 239 994 (G. ETZEL) 15 March 1966 see column 1, line 7 - line 36 see column 8, line 12 - column 10, line 42; figures	1,9,11, 12
A	US,A,4 365 710 (E. SWANSON) 28 December 1982 see column 2, line 12 - column 6, line 6; figures	1,9,11
<p><sup>9</sup> Special categories of cited documents : <sup>10</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search		Date of Mailing of this International Search Report
22 OCTOBER 1992		30. 11. 92
International Searching Authority		Signature of Authorized Officer
EUROPEAN PATENT OFFICE		JAGUSIAK A.H.G. 

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO. US 9205128  
SA 61839**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.  
The members are as contained in the European Patent Office EDP file on  
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-3535189	20-10-70	None	
US-A-3239994		None	
US-A-4365710	28-12-82	None	